

Development of Filter Fabric Barrier to Reduce Aquatic Impacts at Water Intake Structures

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Filter Fabric Barrier Development

- A six-year research program to develop a technology to minimize adverse environmental impact at water intake structures
- Development of a permeable fabric that works as a physical barrier to exclude fish eggs and larvae from entering intake structures
- Resulting technology: Gunderboom Marine Life Exclusion System™ (MLEST™)

Gunderboom MLES™ as an Intake Technology

The Gunderboom MLES™ is currently incorporated in three NYSDEC SPDES permits

- Two closed-cycle facilities
 - Bethlehem Energy Center
 - Bowline Point Generating Station Unit 3
- One once-through facility
 - Lovett Generating Station

Contributors to the Gunderboom Development

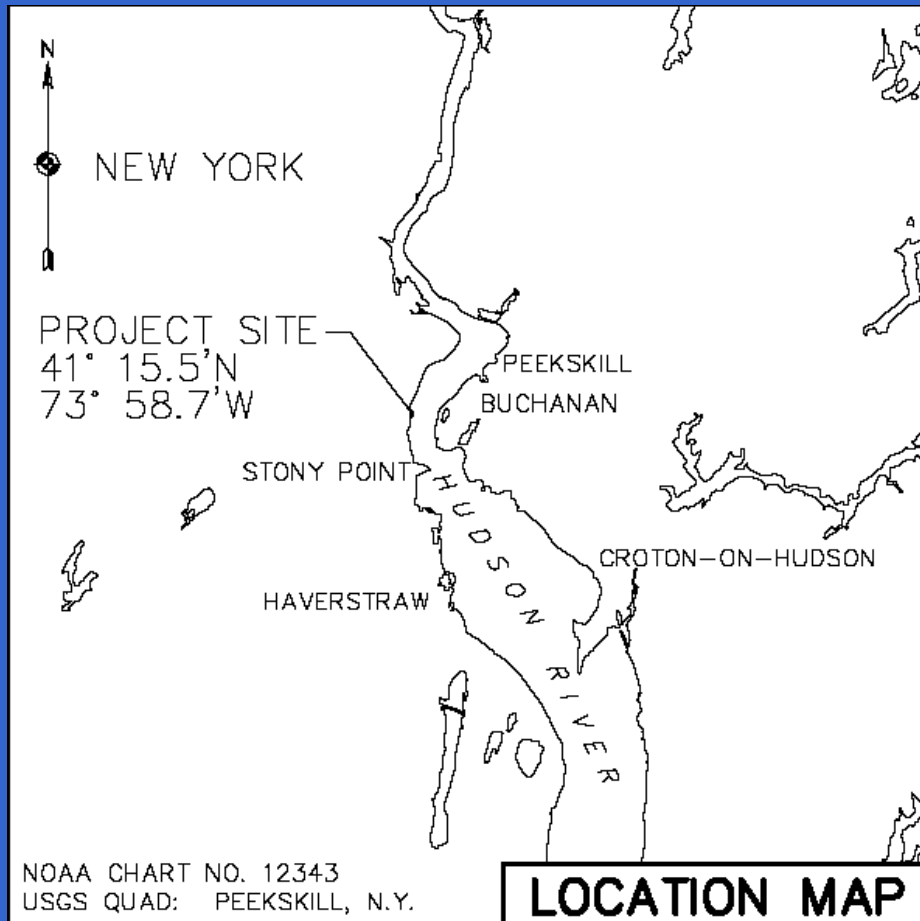
- Orange and Rockland Utilities Inc.
- Mirant Inc. (Southern Company)
- Gunderboom Inc.
- Lawler, Matusky and Skelly Engineers LLP (LMS)
- New York State Department of Environmental Conservation (NYSDEC)
- Hudson Riverkeeper: Pisces Conservation Ltd. / Carpenter Associates

Lovett Generating Station

- Fossil fuel powered
- Three generating units
- 462-MW capacity
- Once-through cooling
- 391-MGD non-contact cooling water



Facility Location



- Tomkins Cove, New York
- West Bank of the Hudson River
- 42 river miles upstream of New York City

Hudson River Characteristics at Lovett

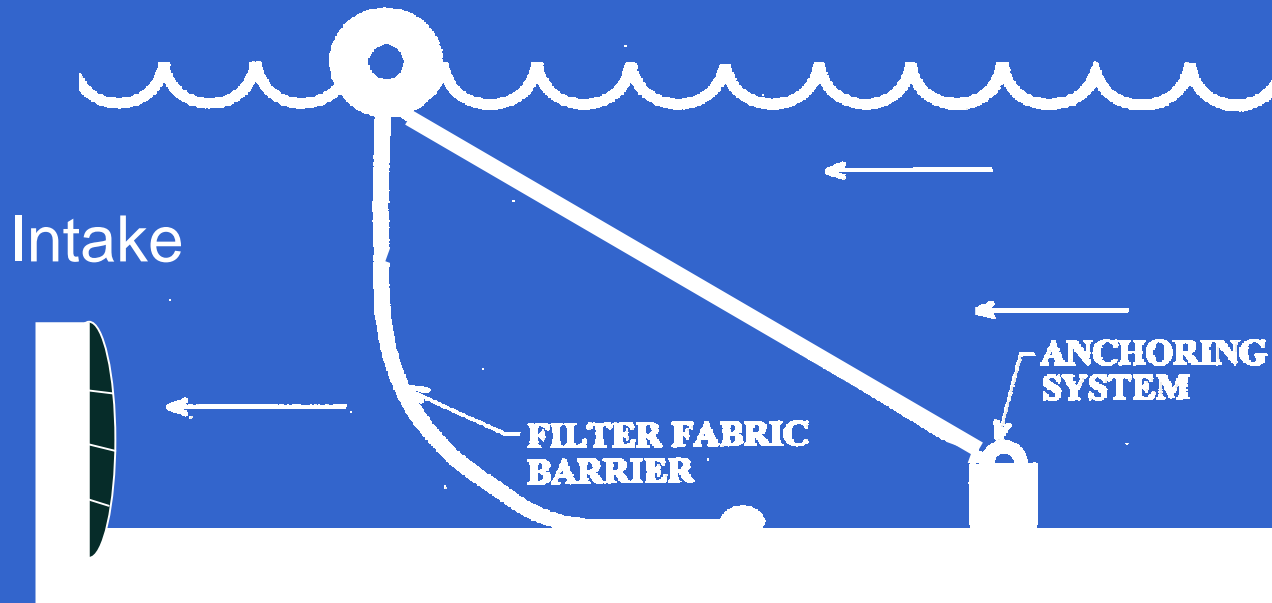


- 160,000 CFS / 3-5 FPS currents
- Tidal range 3 ft / Salinity 0-10 PPT
- Periods of high total suspended solids (TSS)
- 35-ft maintained navigation channel

Site-Specific Considerations

- Select fabric to exclude the smallest size of target species
- Physical limitations of the site
- Water withdrawal requirements and through-fabric flow rates
- Water level fluctuations, currents, waves
- Waterborne sediments, debris, ice, etc.

What is a Filter Fabric Barrier?



- Physical barrier made of permeable fabric
- Interstices of fabric have an Apparent Opening Size (AOS) of 20 - 200 microns

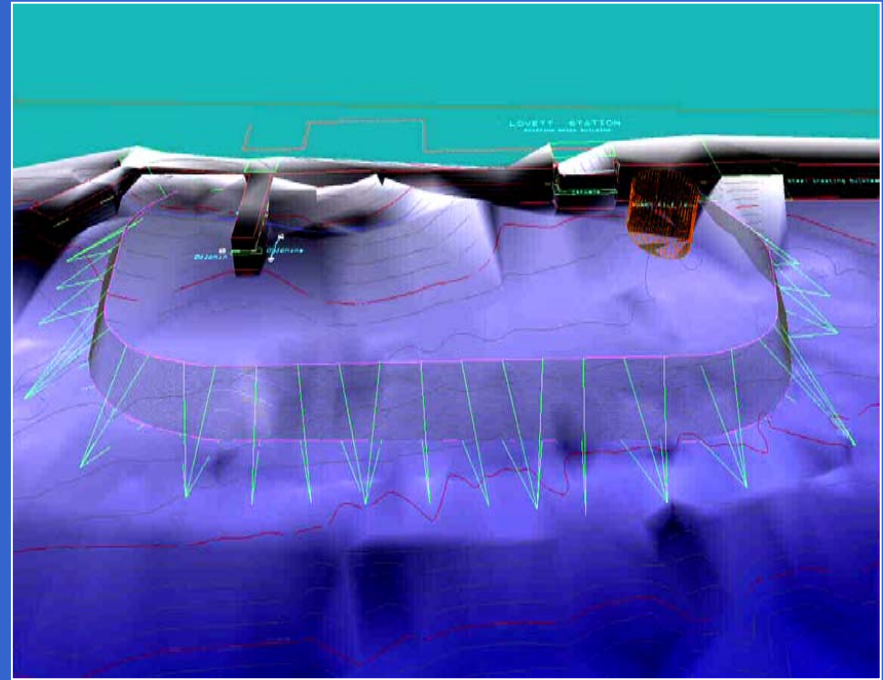
Filter Fabric Perspective



Pre-deployment



Deployment



3-dimensional perspective

Annual Development Goals

1995 - Gunderboom System concept

1996 - Manual AirBurst™ cleaning system / spud-type anchors
(3-unit deployment)

1997 - Manual AirBurst™ cleaning / dead-weight anchoring system

1998 - Automated AirBurst™ cleaning / 500-micron perforations /
monitoring equipment

1999 - Automatic AirBurst™ cleaning / monitoring equipment

2000 - Improve field maintenance procedures, improve mooring
hardware and test new zipper connections

1995 Deployment



- Single-ply fabric
- Approximately 300 ft long
- 20-30 ft deep
- Danforth anchors

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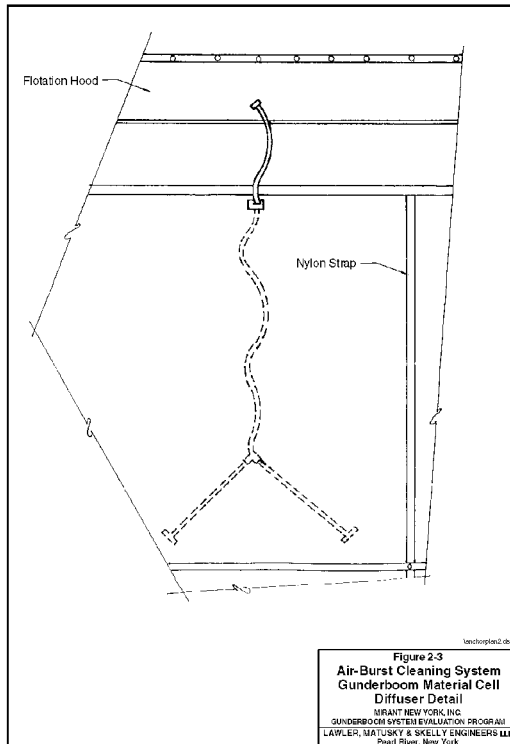
1997 - Manual AirBurst™ cleaning / dead weight anchoring system

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AirBurst™ System



- Two-ply panelized fabric
- Air hose extending to base of fabric
- Compressed air supplied to header
- Air released at depth
- Fabric billows and shakes to remove sediments

AirBurst™ System

- Touch-screen control panel
- Strain Gauges
- Head differential monitors



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2000 Deployment

- Two-ply fabric with 500-micron perforations (8000/ft²)
- Approximately 500 ft long
- 20-30 ft deep
- Dead-weight anchors
- Automated airburst system with strain gauges and head differential monitors



Zipper Test

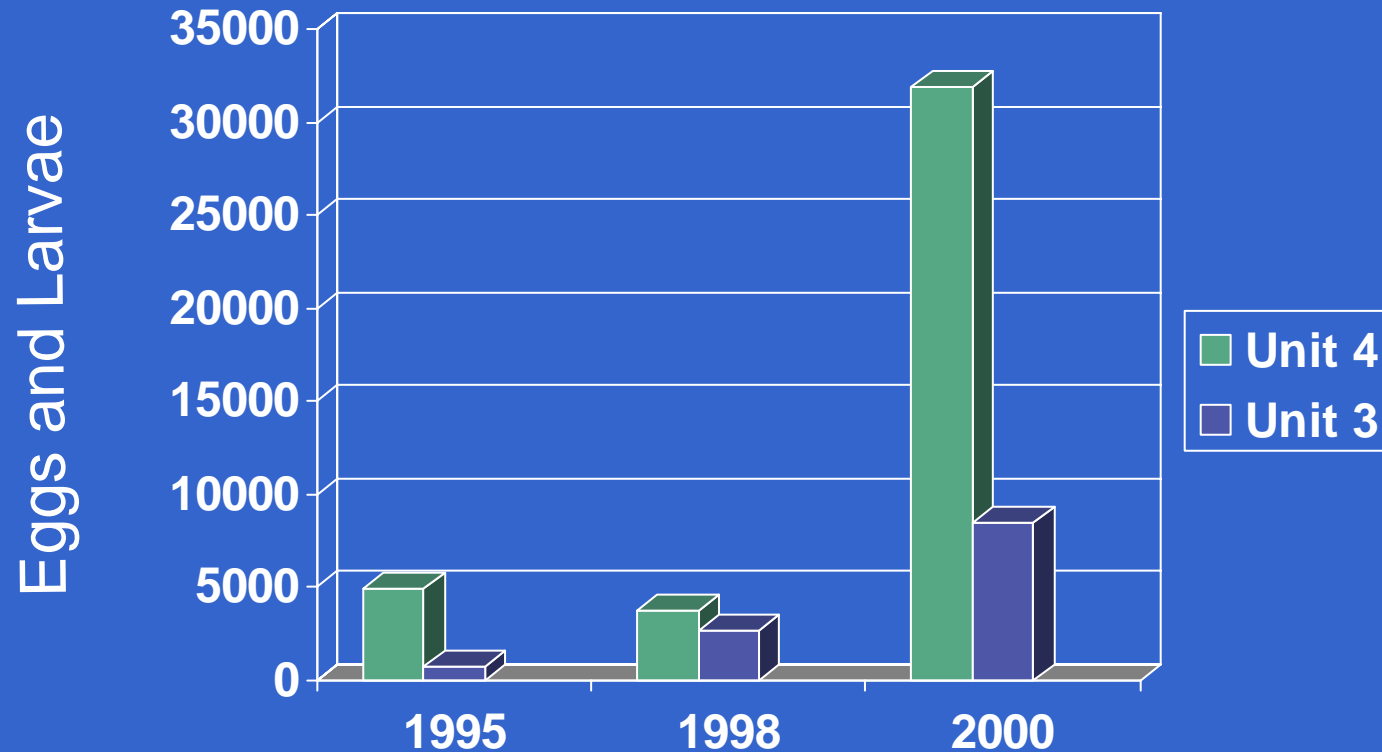


- Improve deployment, removal and maintenance
- Allow for damaged panels to be replaced

Ichthyoplankton Monitoring

- Ichthyoplankton monitoring conducted inside and outside of the MLES™ during 1995, 1998, 2000 deployments
- Overall program resulted in an 80% reduction in ichthyoplankton entering the facility
- Periodic elevated densities inside were linked to breaches of the system

Ichthyoplankton Program



Unit 4 – Unprotected / Unit 3 Protected by Gunderboom

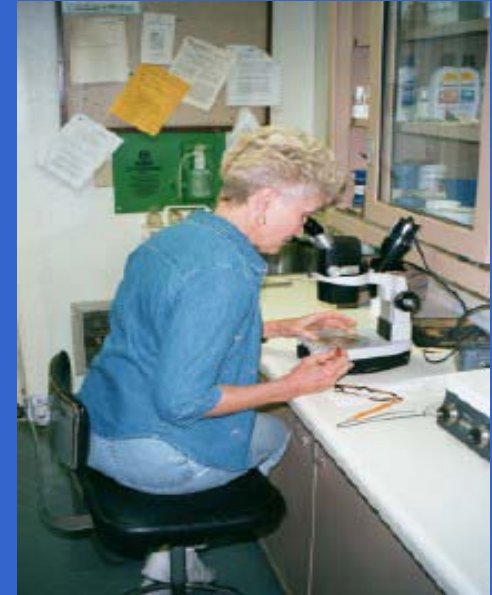
Impingement Experiment

- 24-hr impingement study conducted on American shad
 - 100 eggs added to McDonald Jars with Gunderboom fabric
 - 5 gpm/ft² flow rate
- Swimming studies with day-old American shad
 - Larvae added to flow-through tank with Gunderboom fabric
 - 5 gpm/ft² flow rate



Impingement Experiment Results

- Eggs
 - Did not adhere to fabric
 - 1-2% mortality occurred
 - No difference between mortality in the control jars and mortality in the test jars
- Larvae
 - Did not orient toward flow
 - Did not impinge on fabric with through-fabric velocity of 5 gpm/ft²



Program Observations

- Operated effectively under high river flows, debris conditions, and major storm events
- An effective physical barrier for fish eggs and larvae
- Minimal biological growth experienced; growth did not adversely affect operation
- System will perform best when integrated into facility operations



Program Summary

- Minimize entrainment and impingement
- Maintain in dynamic river environment
- Less expensive than many alternative technologies
- BTA in three NYSDEC SPDES permits
- Being considered by NYSDEC at other selected sites